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PLANNING AND ENGINEERING STUDY ON DEVELOPMENT OF LOK MA CHAU LOOP - INVESTIGATION

Contamination Assessment Plan for Area A

October 2009

CEDD 土木工程拓展署 Civil Engineering and Development Department

規劃署 Planning Department

ARUP

Planning Department and
Civil Engineering and
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Agreement No. CE6153/20072008(CE) Planning and Engineering Study on Development of Lok Ma Chau Loop - Investigation

Contamination Assessment Plan for Area A (CAP for Area A)

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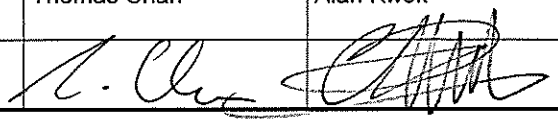
		Signature			

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1 Introduction

1.1 Background

On 26 May 2009, Planning Department (PlanD) in association with Civil Engineering and Development Department (CEDD) commissioned Ove Arup & Partners Hong Kong Limited (Arup) as the Consultant for undertaking the "Planning and Engineering Study on Development of Lok Ma Chau Loop – Investigation" (the Study).

The Study commenced on 1 June 2009 and is expected to complete before end of 2011 in 28 months' time to carry out planning, environmental and engineering feasibility studies and associated site investigation works with a view to formulating land use and development proposals, confirming the feasibility of implementing the land use and development proposals, carrying out preliminary engineering design, and formulating the implementation strategies and programme for delivering the Development and Infrastructure.

Section 3.4.9.4 of the EIA Study Brief No.: ESB-201/2008 for the LMC Loop Development project dated January 2009 issued by the EPD specified that a land contamination assessment shall be undertaken and that a Contamination Assessment Plan (CAP) shall be submitted to the EPD prior to conducting the assessment.

1.2 Study Area

As a result of the training of the Shenzhen River, which serves as the administrative boundary between Hong Kong and Shenzhen, an area of about 87 ha, previously lying to the north of the river course, became situated to the south of the re-aligned river course and falls within the boundary of the HKSAR. The area, commonly known as the Lok Ma Chau Loop (the Loop), was used as a dumping ground for mud dredged from the river training work, some of which were contaminated.

The study area comprises the area within the Loop together with the adjoining area in Hong Kong (i.e. Area A and Area B of **Figure 1.1**). A separate study for the adjoining area in Shenzhen (i.e. Area C of **Figure 1.1**) has been commissioned by the Shenzhen side.

The Loop is located near several major cross-boundary transport nodes including the Lok Ma Chau Control Point, the Lok Ma Chau Station of the Lok Ma Chau Spur Line and the San Tin Interchange. To the north across the Shenzhen River is the Huanggang Control Point of Shenzhen. To the southwest is the Mai Po Nature Reserve and to the northeast is Hoo Hok Wai, comprising fish ponds of high ecological value.

Site characteristics of the LMC Loop and its surrounding land uses are:

- predominantly flat land with grasses and shrubs on it;
- surrounding area mainly rural in nature, comprising mostly wetland, natural landscape, hilly terrain, woodland, village settlements, agricultural land and fishponds;
- the Mai Po Nature Reserve, i.e. the Ramsar Site, is at about 5.4 km to the southwest of the Loop;

- the LMC Station of the LMC Spur Line and the LMC Spur Line Boundary Control Point (BCP) is located in close proximity to the southwest;
- across the Shenzhen River to the north is the Futian CBD District of Shenzhen, where the Huanggang Station of Shenzhen Metro Line can be connected to the LMC Station easily via the LMC Spur Line BCP; and
- apart from the LMC Spur Line BCP, the Loop also lies in close proximity to the Lok Ma Chau BCP.

1.3 Objective

The purpose of this Contamination Assessment Plan (CAP) is to provide information, guidance and instruction to characterise land contamination and identify where any contamination is or may be present during the construction and operation of LMC Loop Area A (a separate CAP will be prepared for Area B). The objectives of this CAP are:

- To provide an account of the land use within project site boundary and relevant past land use history in relation to possible land contamination;
- To identify areas of potential contamination and the associated impacts, risks or hazards; and
- To identify the contaminant of concern and scoping of requirements for sampling and laboratory testing of soil and groundwater sampling.

1.4 Statutory Legislation and Evaluation Criteria

This CAP is prepared in accordance with the following Technical Memorandum and Guidance Notes:

- Annex 19 of the Technical Memorandum on Environmental Impact Assessment Process (TM-EIA), Guidelines for Assessment of Impact On Sites of Cultural Heritage and Other Impacts (Section 3 : Potential Contaminated Land Issues);
- Guidance Notes for Investigation Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, and Car Repairing/Dismantling Workshops, EPD, 1999;
- Guidance Notes for Contaminated Land Assessment and Remediation;
- Guidance Manual for Use of Risk-Based Remediation Goals (RBRGs) for Contaminated Land Management, EPD, 2007.

In accordance with EPD's *Guidance Note for Contamination Land Assessment and Remediation*, a contamination assessment evaluation should:

- provide a clear and detailed account of the present use of the land and the relevant past land history, in relation to possible land contamination;
- identify areas of potential contamination and associated impacts, risks or hazards; and

- submit a plan to evaluate the actual contamination conditions for soil and/or groundwater, if required.

The EPD's Guidance Notes include a summary of the general steps of a detail contamination assessment study.

Under the Annex 19 of the TM-EIAO, consideration shall be given to a number of potentially contaminating historical land uses, including oil installations, gas works, metal workshops, car repair and dismantling workshops, as having the potential to cause or have caused land contamination. It should be noted that none of these types of land uses were identified within the Area A.

Nevertheless, this CAP has been prepared to set out the requirements for a baseline contamination evaluation of the Area A of the Project. A Contamination Assessment Report (CAR) will be prepared following site investigation activities. If significant contamination is identified in the CAR, a Remediation Action Plan (RAP) will be developed to deal with these areas prior to or during the construction works for the Project. The RAP should follow the contents requirements as specified in the EPD's *Guidance Notes for Investigation and Remediation of Contaminated Sites*. A Remediation Report (RR) would be prepared to demonstrate adequate clean-up and submitted to EPD for endorsement prior to the commencement of any construction/ development works of the Project.

2 Initial Site Appraisal

2.1 Desktop Review

A desktop study has been conducted to review past and present landuses, activities and installations within Area A that may pose potential for land contamination.

Existing information from historical land contamination site investigations and other contamination reports for areas located within the vicinity of Area A have been reviewed, including the following:

- Hong Kong Ordinance Survey Maps from various years;
- Relevant Outline Zoning Plans (OZPs) in the vicinity of LMC Loop;
- Hong Kong Geological Survey Map;
- Relevant aerial photos from 1973;
- "Mapping Hong Kong, A Historical Atlas", Government Information Services, 1992;
- Environmental Impact Assessment Study on Shenzhen River Regulation Project - Study Report for Stage 1 Works; Nov., 1994;
- Environmental Impact Assessment Study on Shenzhen River Regulation Project - Final EIA Study Report; Nov., 1995;
- 落馬洲河套地區-土壤污染評估報告-安社亞洲(香港)有限公司, 二零零七年六月; and
- 港深落馬洲河套地區聯合開發項目環境影響評價大綱(送審稿)- 深圳市環境科學研究所, 北京大學, 二零零七年八月.

2.1.1 Review of Aerial Photographs and Historical Landuse

The development history of Area A was reviewed with the aid of aerial photographs. Survey and Mapping Office (SMO) of Lands Department was consulted for the historical aerial photos of Area A. However, aerial photo of Area A was not available until year 2005 (i.e. Area A in aerial photos was filled with white colour before year 2005). The aerial photos taken in years 2005 and 2008 are shown in **Appendix A**.

Although the aerial photos for Area A were not available before year 2005, desktop review of previous reports indicated that Area A mainly consisted of agricultural land in 1970s. Some agricultural lands were changed to fish ponds in 1980s. Area A mainly consisted of fish ponds in early 1990s before the Shenzhen River Training Works started in year 1995.

The Shenzhen River Training Works Stages 1 and 2 were completed in year 2000. Shenzhen River was rechannelled after the training works. Area A was filled by the dredged mud.

Plantation of entire Area A was completed in year 2005 as shown in the aerial photo. In year 2008, Area A remained as grass land and no industrial / economic activity was observed within the site.

2.2 Site Geology

Area A was used as a dumping ground for mud dredged from Shenzhen River Training Works Stages 1 and 2. The dumping activity started in year 1995 and ended in year 2000. Approximately 4Mm^3 of dredged mud was dumped into Area A, with an average filling depth of 5m.

In accordance with the drillhole records provided in 落馬洲河套地區-土壤污染評估報告, Area A was covered by FILL material (i.e. silty fine to medium/coarse SAND) from 0 to 2m below ground level (bgl), and occasionally to a depth of 5mbgl. ALLUVIUM was also found 2 to 5mbgl in depth in most of the locations. Groundwater level in Area A ranged from 0.3 to 1.8mbgl. The drillhole records are given in **Appendix B**.

2.3 Site Background and Reference Information

EIA Study on Shenzhen River Regulation Project – Study Report for Stage 1 Works

According to the EIA Report of Stage 1 Works, the mud in some locations of Shenzhen River was contaminated by heavy metals; especially “Mercury” content was high and could be potentially toxic. The contaminated mud was eventually dredged and disposed of in Area A during Shenzhen River Training Works Stages 1 and 2 from year 1995 to 2000.

落馬洲河套地區 -土壤污染評估報告

Soil sampling and testing works for Area A which included only 5 boreholes in Area A of area over 87ha were commissioned by Shenzhen Municipal Environmental Protection Bureau in August 2006.The works provided some reference for conducting detailed land contamination assessment for Area A under this statutory EIA. The locations of the 5 boreholes are shown in **Figure 2.1**.

The land contamination assessment for Area A in this CAP will be conducted strictly following the requirements of the Statutory EIA Study Brief No ESB-201/2008, Technical Memorandum under the EIAO and other relevant Guidance Notes and Guidance Manual as mentioned in Section 1.4.

港深落馬洲河套地區聯合開發項目環境影響評價大綱(送審稿)

This draft “港深落馬洲河套地區聯合開發項目環境影響評價大綱(送審稿)” completed in August 2007 presented the background information and baseline conditions for areas around the LMC Loop and recommended an assessment protocol for further detailed site investigation on potential land contamination.

While reference has been made to 港深落馬洲河套地區聯合開發項目環境影響評價大綱(送審稿) in formulating the assessment strategy for Area A in this CAP, the requirements of the Statutory EIA Study Brief No ESB-201/2008, Technical Memorandum under the EIAO and other relevant Guidance Notes and Guidance Manual as mentioned in Section 1.4, will be strictly followed in conducting the land contamination assessment for Area A.

2.4 Site Survey

Aerial site survey was conducted in May 2009 to confirm findings of desktop study and to identify any other land uses within Area A which may have the potential for causing soil and groundwater contamination. Possible contaminants were identified in accordance with Annex B of EPD's *Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, and Car Repairing/Dismantling Workshops*.

Area A currently is a flat land with grasses and shrubs. No temporary structure was found in this restricted area. No special land use or activity was observed that may have the potential for causing soil and groundwater contamination.

2.5 Future Landuse and Activities

The RBRGs have developed four different post-restoration land uses, namely "Urban Residential", "Rural Residential", "Industrial" and "Public Parks", to reflect the actual settings which people could be exposed to contaminated soil or groundwater. Definition of post-restoration land uses are given in EPD's *Guidance Note for Contaminated Land Assessment and Remediation and RBRGs Guidance Manual*.

The future land use of Area A is yet to be confirmed in the on-going planning task for Area A which is expected to give clearer picture in early/mid 2010. However, it is aware that the planning study focused on the idea of "higher education, research and development of new high technology and cultural and creative industries". In accordance with EPD's *Guidance Note for Contaminated Land Assessment and Remediation,* these activities should be classified as either 'Rural Residential" or "Urban Residential" under RBRGs landuse category. Corresponding RBRGs landuse of the associated facilities are defined and given in **Table 2.1**.

Table 2.1 Post-restoration land use and RBRGs land use

Landuse	Corresponding RBRGs Landuse
Commercial / Residential • Urban High Rise • Low Rise in Rural Area	 Urban Residential Rural Residential
Commercial / Business & Office	Urban Residential
School	Rural Residential
Public Park with Indoor Games Hall	Lower of Public Park or Urban Residential
Warehouse & Storage	Industrial
Government, Institution & Community Facilities	Urban Residential
Road including Pedestrian Walkway	Lower of Industrial or Public Park
Railway	Industrial
Open Space	Public Park
Public Utilities	Industrial

Planning Study Team was being regularly consulted for the progress of the planning study. In fact, it was expected that the development plan of this 87 ha site would be consisted of different facilities, such as education buildings,

pedestrian walkway, open space, car park and various of public utilities etc. Hence, the most relevant RBRG corresponding to its future land use would be adopted in assessing its land contamination level. Nevertheless, if the future land uses still could not be confirmed or in doubt during the assessment (i.e. interpretation of the soil and groundwater testing results), the most stringent set of RBRGs would be adopted.

3 Potentially Contaminated Sites

3.1 Summary of Potentially Contaminated Sites

Area A (i.e. former agricultural land and fish ponds in 1980s and early 1990s) was used as a dumping ground for mud extracted from Shenzhen River Training Works Stages 1 and 2. Approximately 1Mm^3 contaminated mud and 3Mm^3 uncontaminated mud were dredged and disposed of in Area A from year 1995 to 2000. The depth of the disposed mud in Area A was approximately 5m (i.e. include about 1m to 1.5m thick top layer of uncontaminated mud for capping). However, the disposal pattern, e.g. the disposal location and area of contaminated mud in Area A is unknown. Therefore, the entire Area A is considered as a potentially contaminated site, namely "**Site A**" **(Figure 3.1** and **Table 3.1)**.

Table 3.1 Potentially contaminated landuse

Site ID	Location	Current Land Use	Potential Sources of Contamination	Approximate Area (m²)	Recommended No. of Boreholes(i)
A	Entire Lok Ma Chau Loop (Area A)	Flat land with Grasses and Shrubs	Approx. 1Mm^3 contaminated mud and 3Mm^3 uncontaminated mud were dredged from the Shenzhen River and disposed of in Area A from year 1995 to 2000. Total filling depth in Area A is about 5m, which include 1m to 1.5m thick top layer of uncontaminated mud for capping.	870,000 (87ha)	35

Note(i): The recommendation in 港深落馬洲河套地區聯合開發項目環境影響評價大綱(送審稿) has been taken into account for the determination of the number of boreholes (Refer to Section 5 for details)

4 Potential Human Health and Environmental Impacts

4.1 Potential Impact on Receptors

The potential impacts to the Project from contaminated soil and groundwater are judged by the following risks associated.

- Health risks to site workers;
- Disposal of contaminated soils, where encountered;
- Disposal of contaminated groundwater, where encountered; and
- Potential health risks to future users of the sites.

4.2 Health Risk to Site Workers

Site construction workers may become exposed to contaminated soils and groundwater during earth moving operations and the laying of pipelines or underground services. The main exposure routes for site construction workers are accidental direct ingestion of contaminated materials through poor hygiene and eating or smoking on site, or through direct contact with potentially toxic or harmful contaminants in excavated soil.

4.3 Disposal of Contaminated Soil

In the event that any contaminated soils are identified during site investigation (SI) works or further environmental investigations, they may require remediation or disposal prior to or as part of the construction programme. Prior agreement will need to be reached with EPD so that these materials are dealt with appropriately in accordance with EPD's Guidance Note for Contaminated land Assessment and Remediation. Any contaminated soils which are excavated would require treatment and/or off site disposal at an appropriate site which is licensed to accept "contaminated" soils. The actual type(s) and concentration(s) of contaminants would determine the final disposal requirements, following agreement of the proper disposal option with the Waste Facilities Management Group, and Waste Policy and Service Group of EPD.

It should be noted that the Project Proponent would implement feasible measures to minimize the amount of contaminated soils, if any, to be excavated from the site and to avoid disposal of contaminated soils. Any contaminated soils would be handled, treated and re-used on site as far as possible.

4.4 Contaminated Groundwater Disposal

Where excavations for the Project take place below the groundwater table, there may be a need to dewater the pits for safety and construction purposes. Where dewatering takes place through layers of contaminated material or where any contaminated soil is being excavated, the groundwater may become contaminated, thereby requiring appropriate handling and disposal. Depending on the level of contamination encountered, and subject to the agreement of EPD, groundwater may need to be disposed of in an appropriate manner, compliant with the *WPCO*.

4.5 Potential Health Risks to Future Users of the Site

During the operational phase, there is little potential for impacts associated with contaminated soils. However, maintenance workers may come into contact with such materials, at which time all of the above mentioned impacts may be applicable. However, if contaminated material is identified during the construction stage, it is expected that appropriate remedial measures would have been undertaken so that this material is either mitigated or removed, thus avoiding future, direct contact with in-situ materials.

5 Site Investigation

5.1 Proposed Site Investigation

Potential contamination in Site A has been identified in **Section 3** based on desktop study and site surveys. Site investigation is needed to determine the types and quantities of contaminants within the site.

The area of Site A is about 87 ha. The 港深落馬洲河套地區聯合開發項目環境影響評價大綱(送審稿) recommended a Grid Patterns approach with grid size of 176m x 176m for assessing the level and extent of land contamination in Site A. One borehole would be drilled in each grid, hence, 35 sampling boreholes are required. The current condition and locations of the proposed boreholes in Site A are shown in **Figures 5.1a, 5.1b and 5.2** and summarized in **Table 5.1**.

The depth of filled materials in Site A is approximately 5m, which includes about 1m to 1.5m thick top layer of uncontaminated mud for capping. Therefore, for each proposed borehole, 3 soil samples would be collected at depths of 1.5m, 3.0m and 4.5m respectively.

An on-site Land Contamination Specialist will take the thickness of capping material into account to decide the appropriate depths for soil sampling on a point by point basis during site investigation. If there is doubt about the capping layer exceeding 1.5m, the on-site Land Contamination Specialist will adjust the soil sampling depths. If necessary, soil samples below the depth of 4.5m will be collected in order to ascertain the vertical distribution of contamination. Nevertheless, minimum of 3 soil samples will be collected from each sampling point.

In order to have an overview of groundwater quality in Site A, one groundwater sample would be collected from each of 10 designated boreholes (i.e. evenly distributed in Site A, as shown in **Figure 5.2**), if encountered.

Table 5.1 Sampling strategy for Site A

Locations			Coordinates		Sampling Strategy	
Site ID	**Area (m^2)**	**Borehole No.**	**Easting**	**Northing**	**Termination Level for Env. Sampling (1)**	**Frequency of Sampling (1) (2)**
A (Figures 5.1a, 5.1b & 5.2)	870,000 (87ha)	A-S01	826297	842935	5 mbgl	Drilling of borehole & collection of soil samples at the depths of 1.5m, 3.0m and 4.5m.
		A-S02	826457	842866		
		A-S03	826627	842800		
		A-S04	826089	842857		
		A-S05	826256	842804		
		A-S06	826592	842698		
		A-S07	826203	842637		
		A-S08	826370	842583		
		A-S09	826538	842530		
		A-S10	826706	842476		
		A-S11	825981	842522		
		A-S12	826149	842469		
		A-S13	826485	842361		
		A-S14	846094	842301		
		A-S15	826263	842248		
		A-S16	826431	842194		
		A-S17	826551	842192		
		A-S18	825875	842187		
		A-S19	826042	842133		
		A-S20	826341	842035		
		A-S21	825696	842043		
		A-S22	825989	841966		
		A-S23	826156	841912		
		A-S24	825822	841887		
		A-S25	825944	841825		
		A-SG01	826142	843025	5 mbgl	Drilling of borehole & collection of soil samples at the depths of 1.5m, 3.0m and 4.5m. One groundwater sample should be collected, if encountered.
		A-SG02	826423	842751		
		A-SG03	826738	842631		
		A-SG04	826035	842690		
		A-SG05	826317	842415		
		A-SG06	826622	842323		
		A-SG07	825928	842354		
		A-SG08	826210	842080		
		A-SG09	825821	842019		
		A-SG10	826067	841813		

Note: (1) The proposed Termination Levels for Sampling Frequency are just for reference purpose. The exact termination levels and no. of soil/ groundwater samples of each borehole should be decided by the on-site Land Contamination Specialist.

(2) Historical drillhole records indicated that the groundwater levels in Site A are approximately ranged from 0.3 to 1.8 mbgl, hence, it is likely to encounter the groundwater table.

5.2 Sampling and Testing Strategy

5.2.1 General

The sampling work would be undertaken following appropriate protocols, to minimise the potential for cross-contamination between samples and between different sampling locations. The soil sampling methods are based on techniques developed by USEPA. These methods include decontamination procedures, sample collection, preparation and preservation, and chain-of-custody documentation.

For general land contamination assessments, samples are collected by drillholes as the sampling depth would often exceed 3.0m. This would minimise the chance of cross-contamination between samples that are often observed when using the trial pit method. When conducting intrusive investigations, care would be taken to avoid underground utilities.

Samples for laboratory testing would be taken with clean stainless steel hand tools and clean latex gloves and placed in rigid containers made of a material that is non-reactive with the likely contaminants.

In addition to the samples collected for laboratory analysis, a strata log would be kept for record of additional data to aid in the interpretation of results. Information on the general structure of the subsurface strata including grain size, colour, and wetness, and the depth and thickness of each soil/rock layer would be noted. The presence of any foreign material such as metals, wood, or plastics would also be recorded.

All field personnel would wear adequate personal protective equipment when working in contaminated areas.

5.2.2 Decontamination Procedures

Equipment in contact with the ground would be thoroughly decontaminated between each sampling event to minimize the potential for cross contamination. The equipment would be decontaminated by steam cleaning, then washed with phosphate-free detergent and finally rinsed with water. Moreover, water would not be used during drilling.

A clean area immediately adjacent to the sample location would be established, using a clean plastic sheet, on which all cleaned, and foil wrapped equipment would be placed.

During sampling and decontamination activities, disposable latex gloves would be worn to prevent the transfer of contaminants from other sources. Disposable accessories, such as latex gloves, would be discarded properly after use.

5.2.3 Soil Sampling

Drilling of borehole and collection of soil samples in Site A would be conducted at depths of 1.5m, 3.0m and 4.5m. The on-site Land Contamination Specialist would decide the appropriate depths for sampling on a point by point basis.

As relatively large quantity of soil sample (i.e. up to 4.5kg) is required, undisturbed sample (e.g. U100) would be collected from each sampling depth, if possible. In case the sample is disturbed, sufficient sample (see **Table 5.2**) would be placed in pre-cleaned glass sample jars and zip plastic bags. The jar lid would be covered with laboratory solvent washed aluminium foil and lids. The jar would be filled with no void space (or otherwise if specified by the lab) for samples to be tested for VOCs. Each sample jar would be labelled. Records would be made of the details of the sampling location and other pertinent data. A chain-of-custody form would be completed for the samples. All samples would be stored on ice in portable ice chests between $2^{o}C$ – $4^{o}C$ whilst in the field or in transit.

5.2.4 Groundwater Sampling

Groundwater samples would be collected at 10 designated drillholes when groundwater is encountered. Historical drillhole records of Site A indicated that the water levels ranged approximately from 0.3 to 1.8 mbgl. Hence, it is likely to encounter groundwater at each proposed borehole location. The on-site Land Contamination Specialist would decide whether the groundwater sample would be collected in accordance with the actual hydro-geological situation of the borehole.

Each sample would be truly representative of the groundwater at the point from which it is taken, without dilution or contamination by water from other sources or by other materials. A groundwater monitoring well would be installed at each drillhole, and upon completion of installation of monitoring wells, approximately five times volume of well would be flushed to remove silt and drilling fluid residue from the wells. The wells would then be allowed to stand for a day to permit groundwater conditions to equilibrate. Groundwater level and thickness of free product layer, if present, would be measured by dip meter and interface probe respectively, before groundwater samples are taken. Moreover, prior to groundwater sampling, the sampling wells would be purged (at least three times volumes of well) to remove fine-grained materials and to collect freshly refilled groundwater samples. After purging, one groundwater sample would then be collected at each sampling well with a Teflon bailer. Field measurement of temperature and pH would also be taken for each of the samples. The free products, if present, would also be sampled to allow identification by the laboratory. Typical details of proposed groundwater monitoring well is shown in **Appendix C**.

If the permeability of the surrounding strata and storage is low, dewatering by pumping may dry up the hole, in which case the on-site Land Contamination Specialist would decide whether the requirement to pump out three times the liquid volume is to be waived.

After the dewatering process (and allowing groundwater to percolate back into the hole if it has been pumped dry), enough quantity of groundwater sample would be collected from each drillhole, and then stored in different sample containers for analysis. Immediately after collection, samples would be transferred to labelled sample containers containing the necessary preservatives (supplied by the laboratory). Samples would be stored between $2^{o}C$ – $4^{o}C$, and delivered to the laboratory within 24 hours. All samples would be collected under chain-of-custody protocols.

5.2.5 Elutriate Test

The objective of Elutriate Test is to assess any potential release of contaminants from the filled mud during excavation in Area A, if required in the future.

The elutriate test would be conducted for the deepest soil samples (i.e. 4.5mbgl) collected from 10 boreholes that are designated for groundwater sampling. Preparation of elutriate for the soil samples would be conducted in accordance with the Evaluation of Dredged Material proposed for Discharge in Waters of the US – Testing Manual (Inland Testing Manual), USEPA and USACE, 1998. Testing parameters, analytical methods and reporting limits are as same as for groundwater samples **(Table 5.4)**.

Groundwater of ~5L would be required for preparation of elutriate in the laboratory for each soil sample. Sufficient quantity of groundwater would be collected at the same borehole where the soil sample is collected. The sample holding time for elutriate samples would be 1 week. Additional ~5L of groundwater is required for each sampling borehole for blank test.

Elutriate samples would be prepared by combining approximately 1L (i.e. 2 kg) of soil sample with unfiltered groundwater collected on-site in a soil-to-water ratio of 1:4 by volume in a pre-cleaned container in the laboratory. The mixture would be stirred for 30 minutes on a platform shaker. After the 30 minutes, the mixture would be allowed to settle for 1 hour and the supernatant would then be siphoned off without disturbing the settled material. The decanted solution would be centrifuged to remove particulates prior to chemical analysis (approximately 2000 rpm for 30 min, until visually clear).

5.2.6 Sample Size and Handling Criteria

Recommended sample size, sample containers and preservative procedures for each chemical analysis of the soil and groundwater have been summarized in **Table 5.2**. The containers would be marked with sampling point codes and the depths at which the samples are taken. Samples would be stored between 2^{o}C– 4^{o}C, and delivered to the laboratory within 24 hours.

Table 5.2: Summary of sample handling criteria

Analytical Parameters	Sample Size	Sample Container	Preservation	Notes
Soil Sample				
All major analyses in soil sample (include Moisture Content)	2 X 500g	Glass Jar with Teflon Lined Lid	Refrigeration at 2^{o}C – 4^{o}C	The soil jar must be filled to minimise headspace when volatiles are to be determined.
Grain Size	1.5kg	Zip Plastic Bay	Room Temperature	-
Elutriate Test (1)	2 X 1kg	Glass Jar with Teflon Lined Lid	Refrigeration at 2^{o}C – 4^{o}C	The soil jar must be filled to minimise headspace when volatiles are to be determined.
Groundwater Sample(2)				
Mercury	250ml	Clear Plastic Bottle	Nitric Acid (HNO_3) Refrigeration at 2^{o}C – 4^{o}C	For Dissolved Metals the sample must be filtered prior to acidification.
SVOCs	1L	Amber Glass Bottle with Teflon Lined Cap	Refrigeration at 2^{o}C – 4^{o}C	-
PCBs				
Chlorinated Pesticides				
TOC	40ml	Glass Vial with Teflon Lined Lid	Sulphuric Acid (H_2SO_4) Refrigeration at 2^{o}C – 4^{o}C	-
For preparation of soil Elutriate Test(1)	10L	Amber Glass Bottle with Teflon Lined Cap	Refrigeration at 2^{o}C – 4^{o}C	-

Note: (1) Elutriate Test only for the deepest soil samples of 10 designated boreholes
(2) Groundwater sampling and testing are required for 10 designated boreholes

5.2.7 Analytical Parameters

The collected soil and groundwater samples would be analyzed for the parameters in accordance with the sampling and testing schedule shown in **Table 5.3** and analysed by a HOKLAS accredited laboratory in accordance with the analytical methods given in **Table 5.4.** The proposed testing parameters include:

- ***Semi Volatile Organic Compounds (SVOCs):*** Acenaphthene, Acenaphthylene, Anthracene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g.h.i)perylene, Benzo(k)fluoranthene, Bis-(2-Ethylhexyl)phthalate, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Fluorene, Hexachlorobenzene, Indeno(1,2,3-cd)pyrene, Naphthalene, Phenanthrene, Phenol, Pyrene
- ***Metals:*** Antimony, Arsenic, Barium, Cadmium, Chromium III, Chromium VI, Cobalt, Copper, Lead, Manganese, Mercury, Molybdenum, Nickel, Tin, Zinc
- ***Dioxins / PCBs:*** Dioxins (I-TEQ), PCBs
- ***Cyanide***: Cyanide, free
- ***Chlorinated Pesticides*****:** alpha-BHC, beta-BHC & gamma-BHC, delta-BHC, p,p'-DDE, p,p'-DDD, p,p'-DDT.
- ***Total Organic Carbon (TOC)***
- ***Grain Size / Moisture Content*****:** Grain Size (% <63μm) and Moisture Content (%)

Although the "Chlorinated Pesticides" are not the chemicals of concern (COCs) in RBRGs, the testing results provided in the Shenzhen River Regulation Project Final EIA Study Report indicated that the total concentration of alpha-BHC, beta-BHC, gamma-BHC and delta-BHC, and the total concentration of DDE, DDD and DDT in Shenzhen River sediment were at detectable levels. Hence, testing of these 7 Chlorinated Pesticide parameters is proposed in order to determine the level of pesticide / insecticide residuals left in the filled mud of Area A.

Testing of TOC, Grain Size and Moisture Content is mainly for information gathering. The testing results of these parameters would be taken into consideration for evaluating various remediation methods, during the preparation of Remediation Action Plan, if contamination of Area A is confirmed.

The testing parameters of "Volatile Organic Compounds (VOCs)", "Petroleum Carbon Ranges" and "Tributyltin Oxide (TBTO)" in RBRGs are considered not necessary for the land contamination assessment of Area A in view of the following

1. **VOCs** are organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere. Therefore, accumulation of VOCs in river sediment is not anticipated. Besides, the dredging activities and subsequent disposal of dredged mud into Area A had further encouraged the vaporization of VOCs from the sediment/mud, if any. On the other hand, Area A has remained as grass land and no industrial / economic activity since the completion of Shenzhen River Training Works in year

2000. Hence, VOCs contamination from other industrial activity is also not anticipated.

2. The density of **petroleum** is approximately 800kg/m^3, which means that the specific gravity (density compared to water) of petroleum is approximately 0.8. The density of even higher hydrocarbon ranges of lube oil (i.e. C28 – C35) is approximately 990kg/m^3 and is still slightly lighter than water. Therefore, contamination of petroleum hydrocarbon in sediment (i.e. sinking and accumulating of petroleum hydrocarbon in sediment) is not anticipated. Petroleum contamination from other industrial activity is also not anticipated for the same reason in 1. above on account of the site condition since year 2000.

3. **Tributyltin Oxide (TBTO)** is an organotin compound widely used in TBT–containing commercial products such as biocide (fungicide and molluscicide). TBTO contamination is usually found in shipyards as this chemical had been chiefly used as antifouling pesticide in marine paints. It is unlikely to have large scale shipyards along the Shenzhen River in view of the shallow water depth. Hence, TBTO contamination of sediment is not anticipated.

A HOKLAS accredited testing laboratory should be appointed to conduct chemical analysis for the soil and groundwater samples. All laboratory test methods should be accredited by the HOKLAS or one of its Mutual Recognition Arrangement Partners.

Table 5.3 Sampling and testing schedule

Site ID	Borehole No.	Sample Type	No. of Samples	Testing Parameter							
				SVOCs (1)	Metals (2)	PCBs	Dioxins	Cyanide, free	Chlorinated Pesticides	TOC	Grain Size / Moisture Content
A	A-S01 to A-S25, and A-SG01 to A-SG10 (Total 35)	Soil at all 3 sampling depths	105	✓	✓	✓	✓	✓	✓	✓	✓
	A-SG01 to A-SG10 (Total 10)	Groundwater	10	✓	✓	✓			✓	✓	
	A-SG01 to A-SG10 (Total 10)	Deepest soil sample (for elutriate test)	10	✓	✓	✓			✓		

Note: (1) Only 11 out of 19 SVOCs parameters are required for groundwater sample and soil elutriate test (refer to Table 5.4 for details)
(2) Only "Mercury" test is required for groundwater sample and soil elutriate test.

Table 5.4 Method of analysis for soil and groundwater samples

Parameter	Referenced Analytical Method	Reporting Limit for Soil (mg/kg)	Reporting Limit for Groundwater (mg/L)
SVOCs			
Acenaphthlene	USEPA Method 8270	0.5	0.002
Acenaphthene		0.5	0.002
Anthracene		0.5	0.002
Benzo(a)anthracene		0.5	-
Benzo(a)pyrene		0.5	-
Benze(b)floranthene		1.0	0.001
Benzo(g,h,i)perylene		0.5	-
Benzo(k)fluoranthene		1.0	-
Bis-(2-Ethylhexyl)phthalate		5.0	-
Chrysene		0.5	0.001
Dibenzo(a,h)anthracene		0.5	-
Fluoranthene		0.5	0.002
Fluorene		0.5	0.002
Hexachlorobenzene		0.2	0.004
Indeno(1,2,3-cd)pyrene		0.5	-
Naphthalene		0.5	0.002
Phenanthrene		0.5	0.002
Phenol		0.5	-
Pyrene		0.5	0.002
Metals			
Antimony	USEPA Method 6020	1	-
Arsenic		1	-
Barium		1	-
Cadmium		0.2	-
Chromium III		1	-
Chromium VI		1	-
Cobalt		1	-
Copper		1	-
Lead		1	-
Manganese		1	-
Mercury	APHA 3112B	0.2	0.0005
Molybdenum	USEPA Method 6020	1	-
Nickel		1	-
Tin		1	-
Zinc		1	-
PCBs	USEPA Method 8270	0.1	0.001
Dioxins	USEPA Method 1613B and 8290	5.01 pg/g	-
Cyanide, free	USEPA Method 9010A or APHA 4500CN: I & E	1	-
Chlorinated Pesticides			
alpha-BHC	USEPA Method 8270	0.05	0.0005
beta-BHC & gamma-BHC		0.1	0.001
delta-BHC		0.05	0.0005
p,p'-DDE		0.05	0.0005
p,p'-DDD		0.05	0.0005
p,p'-DDT		0.2	0.002
TOC	APHA 5310B	0.05%	1.0
Grain Size (% <63μm)	GEOSPEC3: 2001 Tests 8.1/ 8.5/ 8.7	1%	-

Parameter	Referenced Analytical Method	Reporting Limit for Soil (mg/kg)	Reporting Limit for Groundwater (mg/L)
Moisture Content (%)	GEOSPEC3: 2001 Test 5.2	0.1%	-

5.2.8 Assessment Criteria

The assessment criteria for the proposed testing parameters are described below:

- **SVOCs, Metals, Dioxins / PCBs, Cyanide**

The chemicals of concern (COCs) listed in Risk-Based Remediation Goals (RBRGs) were referred to proposing the analytical parameters of SVOCs, Metals, Dioxins / PCBs, and Cyanide. The RBRGs for soil and soil saturation limits and RBRGs for groundwater and groundwater solubility limits are given in **Appendix D**. Strategy for selecting appropriate RBRGs corresponding to the future land uses was discussed in Section 2.5.

- **Chlorinated Pesticides**

The testing results provided in the Shenzhen River Regulation Project Final EIA Study Report indicated that the total concentration of alpha-BHC, beta-BHC, gamma-BHC and delta-BHC, and the total concentration of DDE, DDD and DDT in Shenzhen River sediment were at detectable levels. Hence, testing of these 7 Chlorinated Pesticide parameters is proposed in order to determine the level of pesticide / insecticide residuals left in the filled mud of Area A. The "Intervention Value" for soil remediation published in the Netherlands Government Gazette of the 24th February 2000 was referred to establishing the assessment criteria for soil contamination. The assessment criteria of BHCs (i.e. equivalent to HCHs), DDE, DDD and DDT are summarized in **Table 5.5**. The relevant summary tables of the Intervention Value downloaded from the website of Ministry of Housing, Spatial Planning and Environment, Netherland is given in **Appendix E**.

Table 5.5 Assessment criteria extracted from Intervention Value for soil remediation

Contaminant	Soil Sediment (mg/kg dry weight)
DDT / DDD / DDE (total) (1)	4
BHC combined (2)	2

Note: (1) DDT / DDD / DDE is the total of DDT, DDD, DDE
(2) BHC combined is the total of alpha, beta, gamma and delta BHC.

It should be noted that Netherlands is using groundwater for potable purpose, and its stringent "Intervention Value" of groundwater is considered inappropriate in Hong Kong. Therefore, it is recommended to adopt the laboratory's "Reporting Limits" (i.e. details given in Table 5.4) as preliminary screening goals for assessing the groundwater quality. In case elevated level of pesticide is detected (i.e. higher than the reporting limits), a site-specific screening levels would be developed to deal with that particular contaminant(s).

- **TOC, Grain Size, and Moisture Content**

Testing of TOC, Grain Size and Moisture Content is mainly for information gathering. The testing results of these parameters would be taken into

consideration for evaluating various remediation methods, during the preparation of Remediation Action Plan, if contamination of Area A is confirmed.

5.2.9 Storage of Surplus Soil Samples

Landfill disposal may be a practical option if the scale of contamination is localized and the quantity of soil expected to require cleanup is small. Additional tests in terms of Toxicity Characteristic Leaching Procedure (TCLP) would be required to meet the criteria for disposal to landfills. Hence, surplus soil samples obtained during the site investigation would be stored for subsequent TCLP tests if identified necessary.

Nevertheless, as mentioned in Section 4.3, the Project Proponent would implement feasible measures to minimize the amount of contaminated soils, if any, to be excavated from the site and to avoid disposal of contaminated soils, Any contaminated soils would be handled, treated and re-used on site as far as possible, and the landfill disposal would be treated as last resort for handling of contaminated soils.

Landfill disposal criteria for contaminated soil is shown in **Table 5.7**.

Table 5.7 Landfill disposal criteria for contaminated soil

Parameter	TCLP Limit (ppm)	Referenced Analytical Method	Detection Limit (mg/L)
Cadmium	10	USEPA Method 1311 and 6020	0.2
Chromium	50		1
Copper	250		1
Nickel	250		1
Lead	50		1
Zinc	250		1
Mercury	1		0.2
Tin	250		1
Silver	50		1
Antimony	150		1
Arsenic	50		1
Beryllium	10		1
Thallium	50		1
Vanadium	250		1
Selenium	1		0.2
Barium	1000		1

Ref: EPD's Guidance Notes for Investigation and Remediation of Contaminated Sites of: Petrol Filling Stations, Boatyards, Car Repair/ Dismantling Workshops

5.2.10 Quality Control and Quality Assurance (QA/QC)

A proper QA/QC program would be established so that the data collected are accurate and representative of actual soil and groundwater conditions. The QA/QC programme would include the following:

- 1 duplicate per 20 samples;
- 1 equipment blank per 20 samples;
- 1 field blank per 20 samples; and
- 1 trip blank per trip for the analysis of volatile parameters.

5.2.11 Sample Handling, Packaging and Transport

The soil and groundwater sampling would be conducted by an experienced sampling technician (provided by the G.I. Contractor) and supervised by an on-site Land Contamination Specialist, and appropriate procedures would be adhered to. Sampling methodologies are based on the techniques developed by the USEPA. Sampling tools would be cleaned thoroughly before, in-between and after each sampling. Special care would be taken to prevent any cross contamination of the samples during collection, handling, and storage.

Sample containers would be laboratory cleansed, airtight, and made of glass or other suitable materials with Teflon-lined lids to so that the container does not react with the sample or absorb contaminants. Care would be taken when recording and labelling the sample information on the containers. Information such as the date/time, sample point codes, depths, and any other relevant data would be included. Samples would be stored in an icebox (at about $2^{o}C$ – $4^{o}C$) immediately after collection and labelled, until they are transported to the laboratory for analysis.

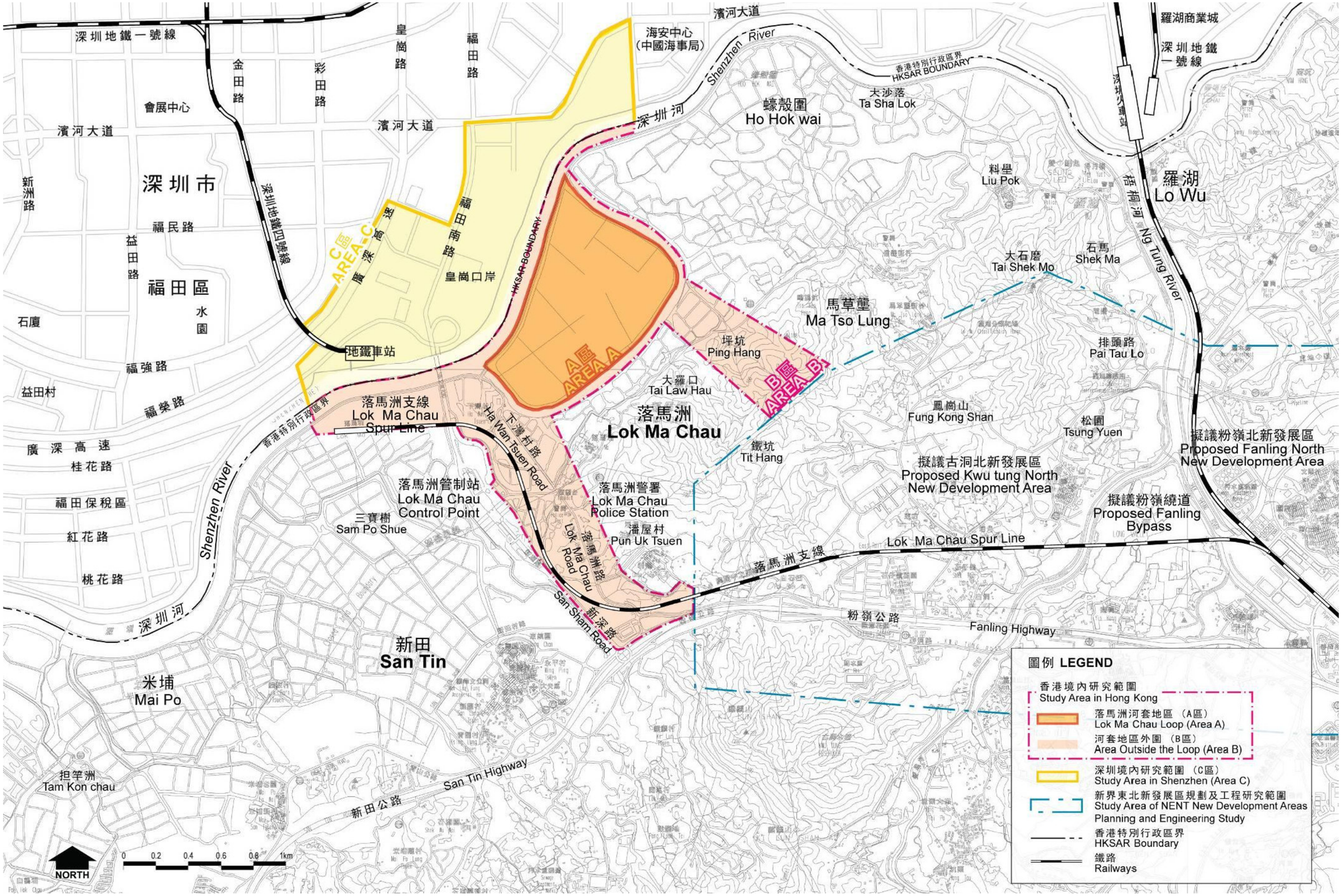
6 Remediation Measures

Following the submission of CAP and completion of SI and lab testing works, a Contamination Assessment Report (CAR) would be prepared. The CAR would present the findings of the site investigation and evaluate the level and extent of potential contamination in Site A. The CAR would evaluate the potential environmental and human health impacts based on the extent of potential contamination identified. If remediation is required, a Remediation Action Plan (RAP) would be prepared. The objectives of the RAP are:

- To undertake further site investigation where required;
- To evaluate and recommended appropriate remedial measures for the contaminated materials identified in the assessment;
- To recommend good handling practices for the contaminated materials during all stages of the remediation works;
- To recommend approximate handling and disposal measures; and
- To formulate optimal and cost-effective mitigation and remedial measures for EPD's agreement.

A Remediation Report (RR) to demonstrate adequate clean-up would be prepared and submitted to EPD for endorsement prior to the commencement of any construction/ development works within Site A. No construction/ development works would be carried out prior to the endorsement of the RR.

Figures



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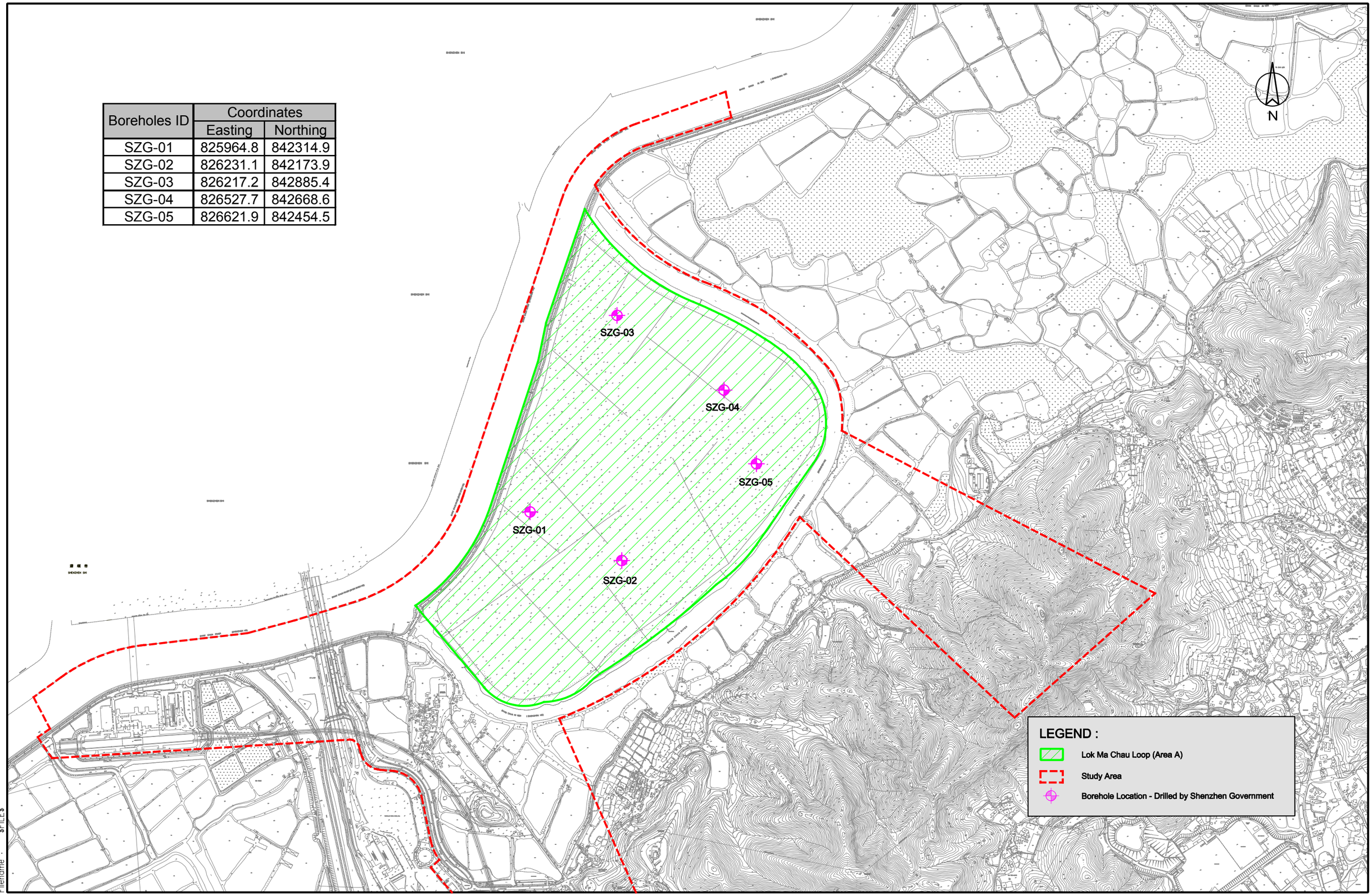
土木工程拓展署 CIVIL ENGINEERING AND DEVELOPMENT DEPARTMENT	規劃署 PLANNING DEPARTMENT	ARUP Ove Arup & Partners Hong Kong Limited	Job Title: Agreement No. CE 53/2008 (CE) Planning and Engineering Study on Development of Lok Ma Chau Loop - Investigation	Drawing Title: **Study Area Plan**	FIRST ISSUE 06/09 (Rev / Description / Date)	Drawn: LK Date: 06/09 Checked: TC Approved: ST Scale: As Shown	Drawing No.: **Figure 1.1** Rev.

Boreholes ID	Coordinates	
	Easting	Northing
SZG-01	825964.8	842314.9
SZG-02	826231.1	842173.9
SZG-03	826217.2	842885.4
SZG-04	826527.7	842668.6
SZG-05	826621.9	842454.5



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土木工程拓展署
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Ove Arup & Partners Hong Kong Limited

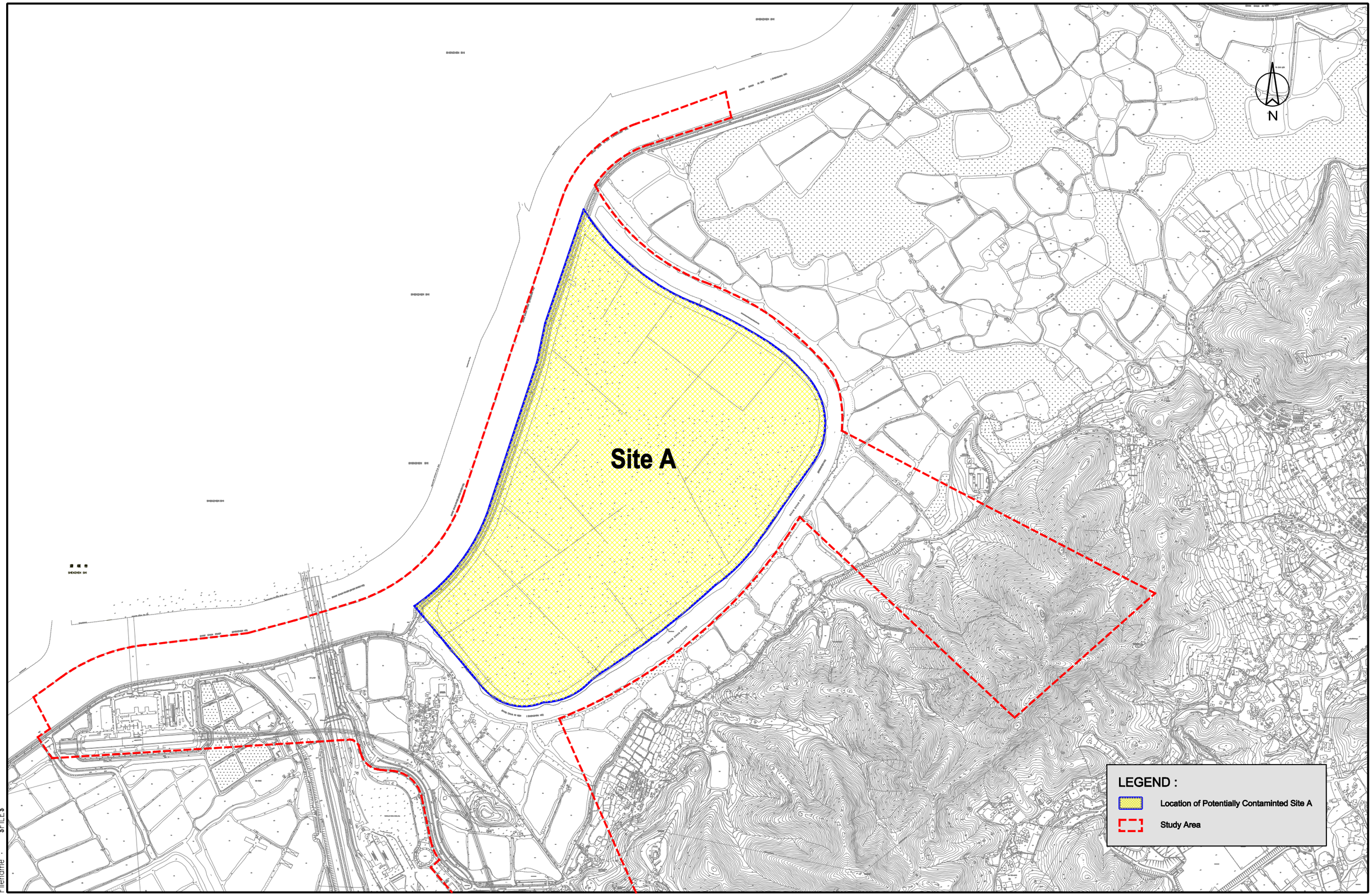
Job Title
Agreement No. CE 53/2008 (CE)
Planning and Engineering Study on
Development of Lok Ma Chau Loop - Investigation

Drawing Title
Contamination Assessment Plan - Locations of Boreholes in Area A Drilled by Shenzhen Government

Rev	Description	Date
	FIRST ISSUE	06/09

Drawn LK | Date 06/09
Checked TC | Approved ST
Scale 1:10000 ON A3

Drawing No.
Figure 2.1
Rev.



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CEDD 土木工程拓展署 CIVIL ENGINEERING AND DEVELOPMENT DEPARTMENT	規劃署 PLANNING DEPARTMENT	ARUP Ove Arup & Partners Hong Kong Limited	Job Title: Agreement No. CE 53/2008 (CE) Planning and Engineering Study on Development of Lok Ma Chau Loop - Investigation	Drawing Title: **Location of Potentially Contaminated Site A**	Rev: FIRST ISSUE — Description — Date: 06/09	Drawn: LK; Date: 06/09; Checked: TC; Approved: ST; Scale: 1:10000 ON A3

Drawing No.: **Figure 3.1**
Rev.

Printed by : $DATE$
Filename : $FILE$

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Job Title
Agreement No. CE 53/2008 (CE)
Planning and Engineering Study on
Development of Lok Ma Chau Loop - Investigation

Drawing Title
Current Condition of Potentially Contaminated Site A (View from South to North)

Rev	Description	Date
	FIRST ISSUE	06/09

Drawn: LK | Date: 06/09
Checked: TC | Approved: ST
Scale: 1:10000 ON A3

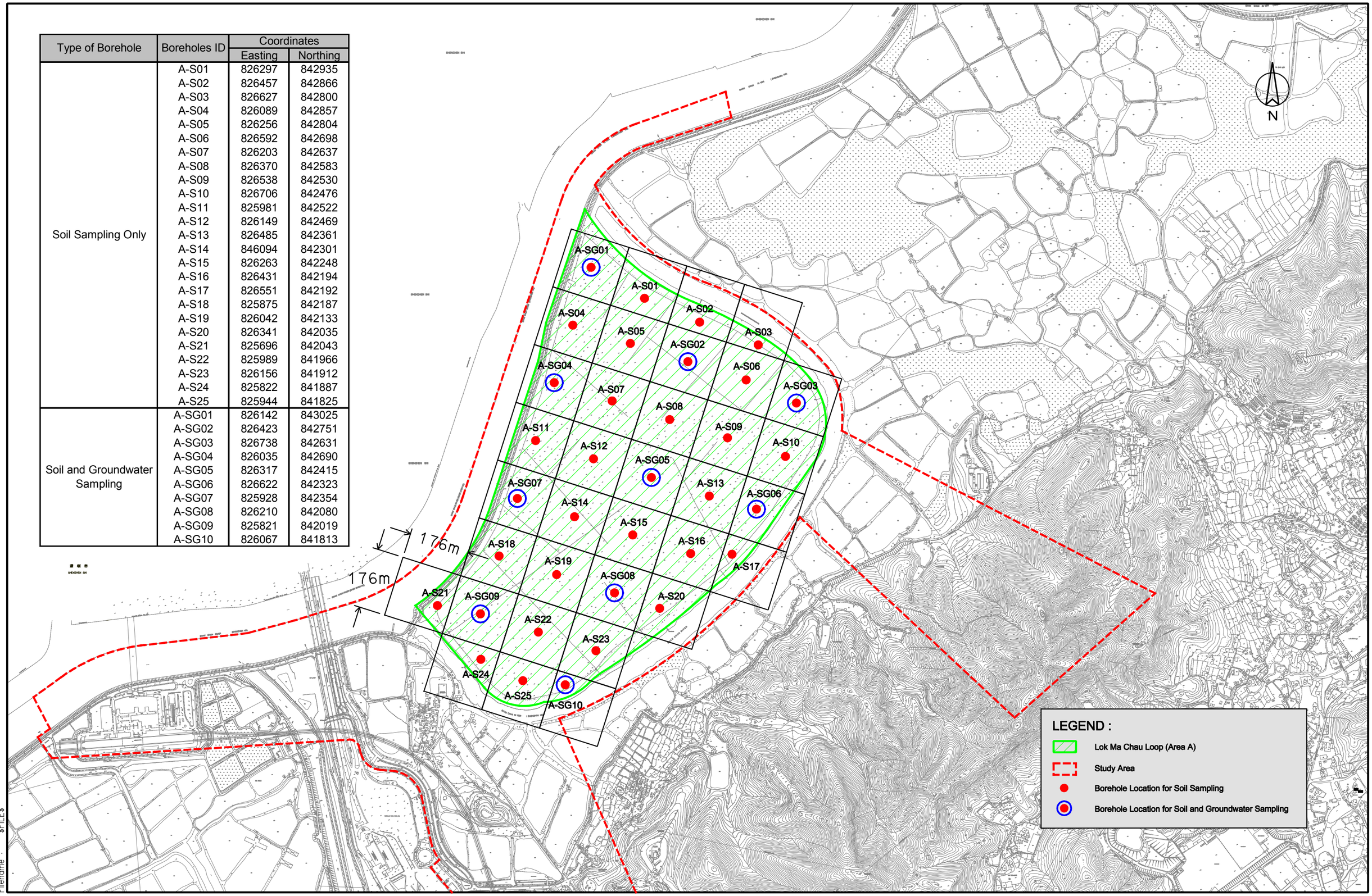
Drawing No.
Figure 5.1a

Rev.

Printed by : $DATE$
Filename : $FILE$

土木工程拓展署 CIVIL ENGINEERING AND DEVELOPMENT DEPARTMENT	規劃署 PLANNING DEPARTMENT	ARUP Ove Arup & Partners Hong Kong Limited	Job Title: Agreement No. CE 53/2008 (CE) Planning and Engineering Study on Development of Lok Ma Chau Loop - Investigation	Drawing Title: **Current Condition of Potentially Contaminated Site A (View from East to West)**	Rev: FIRST ISSUE; Description; Date: 06/09	Drawn: LK; Date: 06/09; Checked: TC; Approved: ST; Scale: 1:10000 ON A3	Drawing No.: **Figure 5.1b**; Rev.

Type of Borehole	Boreholes ID	Coordinates	
		Easting	Northing
Soil Sampling Only	A-S01	826297	842935
	A-S02	826457	842866
	A-S03	826627	842800
	A-S04	826089	842857
	A-S05	826256	842804
	A-S06	826592	842698
	A-S07	826203	842637
	A-S08	826370	842583
	A-S09	826538	842530
	A-S10	826706	842476
	A-S11	825981	842522
	A-S12	826149	842469
	A-S13	826485	842361
	A-S14	846094	842301
	A-S15	826263	842248
	A-S16	826431	842194
	A-S17	826551	842192
	A-S18	825875	842187
	A-S19	826042	842133
	A-S20	826341	842035
	A-S21	825696	842043
	A-S22	825989	841966
	A-S23	826156	841912
	A-S24	825822	841887
	A-S25	825944	841825
Soil and Groundwater Sampling	A-SG01	826142	843025
	A-SG02	826423	842751
	A-SG03	826738	842631
	A-SG04	826035	842690
	A-SG05	826317	842415
	A-SG06	826622	842323
	A-SG07	825928	842354
	A-SG08	826210	842080
	A-SG09	825821	842019
	A-SG10	826067	841813



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Drawn: LK	Date: 06/09	Drawing No.	**Figure 5.2**
Checked: TC	Approved: ST		
Scale: 1:10000 ON A3		Rev.	

Appendices

Appendix A

Historical Aerial Photos

Historical Aerial Photographs of Lok Ma Chau Loop (Area A)

Year 2005

Year 2008

Appendix B

Historical Drillhole Records

TEEMWAY ENGINEERING LTD.

DRILLHOLE RECORD

JOB NO. :
HOLE NO. : BH2
SHEET : 1 OF 1
DATE : 21/8/06 TO 22/8/06

PROJECT : LOK MA CHAU LOOP

METHOD : ROTARY	CO-ORDINATES	ROCK COREBIT :
MACHINE & NO. : XY-2B	E 826231.10 N 842173.90	HOLE DIA. : HX
FLUSHING MEDIUM : NIL	ORIENTATION : VERTICAL	GROUND LEVEL : mPD.

Drilling Progress	Casing Depth/Size	Water Level/Time	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R. Q. D.	Fracture Index	Tests	Samples No.	Type	Depth	Reduced Level	Depth (m)	Legend	Grade	Zone	Description
21/8	HX												0.00				Greyish brown, sandy fine to coarse GRAVEL sized rock fragments. (FILL)
									1		1.00 1.50						
													2.00				Greyish brown, silty fine SAND. (FILL)
									2		2.25 2.75		3.00				Grey, silty CLAY. (ALLUVIUM)
									3		4.30 4.80						
22/8	5.00 HX	0.30m											5.00				End of hole at 5.00m.

- e Small disturbed sample
- Large disturbed sample
- SPT liner sample
- U76 undisturbed sample
- U100 undisturbed sample
- Mazier sample
- P/S Piston sample
- Water sample
- Water table
- Standard penetration test
- Permeability test
- Piezometer tip
- Standpipe

LOGGED W. C. Ma
DATE 31/08/2006
CHECKED W. K. Young
DATE 01/09/2006

REMARKS

Hand Dig Inspection Pit 0.00m-0.50m.

TEEMWAY ENGINEERING LTD.

DRILLHOLE RECORD

JOB NO. :
HOLE NO. : BH1
SHEET : 1 OF 1
DATE : 23/8/06 TO 23/8/06

PROJECT : LOK MA CHAU LOOP

METHOD : ROTARY	CO-ORDINATES	ROCK COREBIT :
MACHINE & NO. : XY-2B	E 825964.80 N 842314.90	HOLE DIA. : HX
FLUSHING MEDIUM : NIL	ORIENTATION : VERTICAL	GROUND LEVEL : mPD.

Drilling Progress	Casing Depth/Size	Water Level/Time	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R. Q. D.	Fracture Index	Tests	Samples No.	Samples Type	Samples Depth	Reduced Level	Depth (m)	Legend	Grade	Zone	Description
23/8	Hx												0.00				Greyish brown, mottled with black, slightly clayey silty fine to coarse SAND with occasional fine gravels. (FILL)
									1		1.00 1.50						
													2.00				Yellowish brown and pink, clayey SILT. (ALLUVIUM)
									2		2.30 2.80						
									3		4.30 4.80						
23/8	5.00 Hx	1.80m											5.00				End of hole at 5.00m.

- Small disturbed sample
- Large disturbed sample
- SPT liner sample
- U76 undisturbed sample
- U100 undisturbed sample
- Mazier sample
- P/S Piston sample
- Water sample
- Water table
- Standard penetration test
- Permeability test
- Piezometer tip
- Standpipe

LOGGED W. C. Ma
DATE 31/08/2006
CHECKED W. K. Young
DATE 01/09/2006

REMARKS

Hand Dig Inspection Pit 0.00m-0.50m.

TEEMWAY ENGINEERING LTD.

DRILLHOLE RECORD

JOB NO. :
HOLE NO. : BH3
SHEET : 1 OF 1
DATE : 24/8/06 TO 24/8/06

PROJECT : LOK MA CHAU LOOP

METHOD : ROTARY	CO-ORDINATES	ROCK COREBIT :
MACHINE & NO. : XY-2B	E 826217.20 N 842885.40	HOLE DIA. : HX
FLUSHING MEDIUM : NIL	ORIENTATION : VERTICAL	GROUND LEVEL : mPD.

Drilling Progress	Casing Depth/Size	Water Level/Time	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R. Q. D.	Fracture Index	Tests	Samples No. Type Depth	Reduced Level	Depth (m)	Legend	Grade	Zone	Description
24/8	Hx								1 1.00 1.50 2 2.30 2.75 3 4.30 4.75		0.00 2.00 3.50 5.00				Reddish brown, silty fine to coarse SAND with fine gravels. (FILL) Greyish brown, mottled with black, clayey SILT. (ALLUVIUM) Grey, slightly silty fine to coarse SAND with quartz gravels. (ALLUVIUM) End of hole at 5.00m.
24/8	5.00 Hx	0.30m													

- B Small disturbed sample
- D Large disturbed sample
- SPT SPT liner sample
- U76 U76 undisturbed sample
- U100 U100 undisturbed sample
- M Mazier sample
- P/S Piston sample
- Water sample
- Water table
- Standard penetration test
- Permeability test
- Piezometer tip
- Standpipe

LOGGED W. C. Mo
DATE 31/08/2006
CHECKED W. K. Young
DATE 01/09/2006

REMARKS

Hand Dig Inspection Pit 0.00m-0.50m.

TEEMWAY ENGINEERING LTD.

DRILLHOLE RECORD

JOB NO. :
HOLE NO. : BH4
SHEET : 1 OF 1
DATE : 25/8/06 TO 25/8/06

PROJECT : LOK MA CHAU LOOP

METHOD : ROTARY	CO-ORDINATES	ROCK COREBIT :
MACHINE & NO. : XY-2B	E 826527.70 N 842668.60	HOLE DIA. : HX
FLUSHING MEDIUM : NIL	ORIENTATION : VERTICAL	GROUND LEVEL : mPD.

Drilling Progress	Casing Depth/Size	Water Level/Time	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R. Q. D.	Fracture Index	Tests	Samples No.	Type	Depth	Reduced Level	Depth (m)	Legend	Grade	Zone	Description
25/8	Hx												0.00				Greyish brown, silty fine to coarse SAND. (FILL)
									1		1.00 1.50						
													2.00				Greyish brown, silty fine to coarse SAND with fine to coarse gravels. (ALLUVIUM)
									2		2.30 2.75						
									3		4.35 4.80						
25/8	5.00 Hx	0.50m											5.00				End of hole at 5.00m.

- Small disturbed sample
- Large disturbed sample
- SPT liner sample
- U76 undisturbed sample
- U100 undisturbed sample
- Mazier sample
- P/S Piston sample
- Water sample
- Water table
- Standard penetration test
- Permeability test
- Piezometer tip
- Standpipe

LOGGED W. C. Ma
DATE 31/08/2006
CHECKED W. K. Young
DATE 01/09/2006

REMARKS

Hand Dig Inspection Pit 0.00m-0.50m.

TEEMWAY ENGINEERING LTD.

DRILLHOLE RECORD

JOB NO. :
HOLE NO. : BH5
SHEET : 1 OF 1
DATE : 26/8/06 TO 26/8/06

PROJECT : LOK MA CHAU LOOP

METHOD : ROTARY	CO-ORDINATES	ROCK COREBIT :
MACHINE & NO. : XY-2B	E 826621.90 N 842454.50	HOLE DIA. : HX
FLUSHING MEDIUM : NIL	ORIENTATION : VERTICAL	GROUND LEVEL : mPD.

Drilling Progress	Casing Depth/Size	Water Level/Time	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R. Q. D.	Fracture Index	Tests	Samples No.	Type	Depth	Reduced Level	Depth (m)	Legend	Grade	Zone	Description
26/8	HX												0.00				Reddish brown, silty fine to medium SAND. (FILL)
									1		1.00 1.50						
													2.00				Greyish brown, mottled with black, slightly clayey silty fine to medium SAND. (FILL)
									2		2.30 2.75						
									3		4.30 4.75						
26/8	5.00 HX	0.50m											5.00				End of hole at 5.00m.

- Small disturbed sample
- Large disturbed sample
- SPT liner sample
- U76 undisturbed sample
- U100 undisturbed sample
- Mazier sample
- P/S Piston sample
- Water sample
- Water table
- Standard penetration test
- Permeability test
- Piezometer tip
- Standpipe

LOGGED W. C. Ma
DATE 31/08/2006
CHECKED W. K. Young
DATE 01/09/2006

REMARKS

Hand Dig Inspection Pit 0.00m-0.50m.

Appendix C

Typical Groundwater Monitoring Well

Recommended Good Practice for Piezometer Installations

1 Avoid the use of open standpipes unless specifically instructed by the Design Engineer

2 Review geological conditions and complete the proforma prior to instructing the Contractor

3 Response zones should typically be between 1.5 m to 2.0 m. Longer lengths can be specified provided the response zone remains in similar strata throughout.

4 Response zones that straddle two geological strata should be avoided.

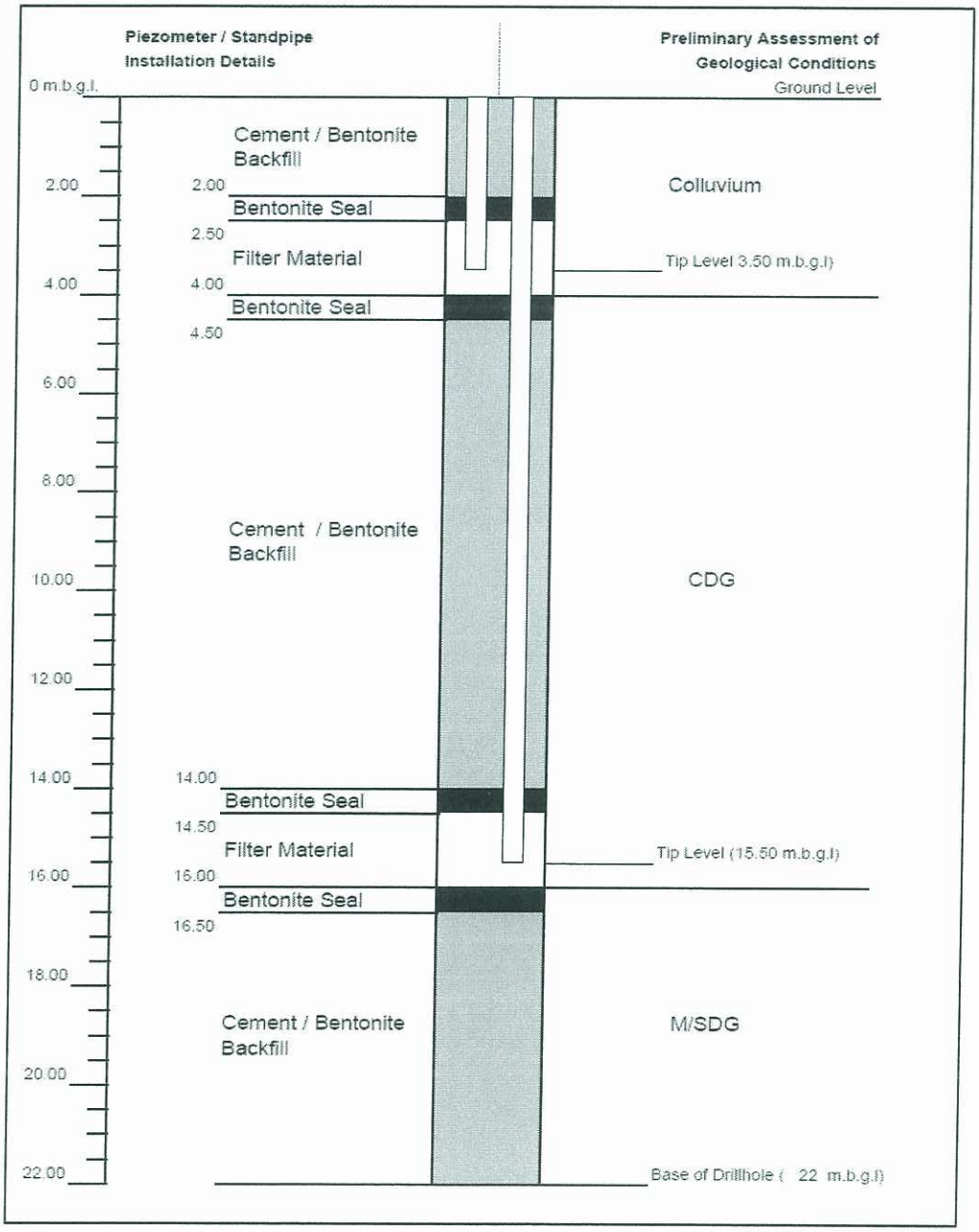
5 Piezometer tips should be installed 500 mm above the base of the response zone.

6 The top and botton of the response zone should be sealed with min 500 mm bentonite seal.

7 1:1 cement bentonite backfill should be used to backfill remaining areas of the drillhole.

8 Typically, no more than 2 piezometers should be installed in a standard 101 mm diameter drillhole. Additional piezometers should only be specified for drillholes with diameter >140 mm.

9 A typical example of a 'good' piezometer installation is provided below:



10 **However, installation requirements may vary based on project specific requirements. If in doubt, consult the Design Engineer.**

Appendix D

RBRGs Criteria

Table 2.1
Risk-Based Remediation Goals (RBRGs) for Soil & Soil Saturation Limit

Chemical	Risk-Based Remediation Goals for Soil				Soil Saturation Limit (C_{sat}) (mg/kg)
	Urban Residential (mg/kg)	Rural Residential (mg/kg)	Industrial (mg/kg)	Public Parks (mg/kg)	
VOCs					
Acetone	9.59E+03	4.26E+03	1.00E+04*	1.00E+04*	***
Benzene	7.04E-01	2.79E-01	9.21E+00	4.22E+01	3.36E+02
Bromodichloromethane	3.17E-01	1.29E-01	2.85E+00	1.34E+01	1.03E+03
2-Butanone	1.00E+04*	1.00E+04*	1.00E+04*	1.00E+04*	***
Chloroform	1.32E-01	5.29E-02	1.54E+00	2.53E+02	1.10E+03
Ethylbenzene	7.09E+02	2.98E+02	8.24E+03	1.00E+04*	1.38E+02
Methyl tert-Butyl Ether	6.88E+00	2.80E+00	7.01E+01	5.05E+02	2.38E+03
Methylene Chloride	1.30E+00	5.29E-01	1.39E+01	1.28E+02	9.21E+02
Styrene	3.22E+03	1.54E+03	1.00E+04*	1.00E+04*	4.97E+02
Tetrachloroethene	1.01E-01	4.44E-02	7.77E-01	1.84E+00	9.71E+01
Toluene	1.44E+03	7.05E+02	1.00E+04*	1.00E+04*	2.35E+02
Trichloroethene	5.23E-01	2.11E-01	5.68E+00	6.94E+01	4.88E+02
Xylenes (Total)	9.50E+01	3.68E+01	1.23E+03	1.00E+04*	1.50E+02
SVOCs					
Acenaphthene	3.51E+03	3.28E+03	1.00E+04*	1.00E+04*	6.02E+01
Acenaphthylene	2.34E+03	1.51E+03	1.00E+04*	1.00E+04*	1.98E+01
Anthracene	1.00E+04*	1.00E+04*	1.00E+04*	1.00E+04*	2.56E+00
Benzo(a)anthracene	1.20E+01	1.14E+01	9.18E+01	3.83E+01	
Benzo(a)pyrene	1.20E+00	1.14E+00	9.18E+00	3.83E+00	
Benzo(b)fluoranthene	9.88E+00	1.01E+01	1.78E+01	2.04E+01	
Benzo(g,h,i)perylene	1.80E+03	1.71E+03	1.00E+04*	5.74E+03	
Benzo(k)fluoranthene	1.20E+02	1.14E+02	9.18E+02	3.83E+02	
bis-(2-Ethylhexyl)phthalate	3.00E+01	2.80E+01	9.18E+01	9.42E+01	
Chrysene	8.71E+02	9.19E+02	1.14E+03	1.54E+03	
Dibenzo(a,h)anthracene	1.20E+00	1.14E+00	9.18E+00	3.83E+00	
Fluoranthene	2.40E+03	2.27E+03	1.00E+04*	7.62E+03	
Fluorene	2.38E+03	2.25E+03	1.00E+04*	7.45E+03	5.47E+01
Hexachlorobenzene	2.43E-01	2.20E-01	5.82E-01	7.13E-01	
Indeno(1,2,3-cd)pyrene	1.20E+01	1.14E+01	9.18E+01	3.83E+01	
Naphthalene	1.82E+02	8.56E+01	4.53E+02	9.14E+02	1.25E+02
Phenanthrene	1.00E+04*	1.00E+04*	1.00E+04*	1.00E+04*	2.80E+01
Phenol	1.00E+04*	1.00E+04*	1.00E+04*	1.00E+04*	7.26E+03
Pyrene	1.80E+03	1.71E+03	1.00E+04*	5.72E+03	
Metals					
Antimony	2.95E+01	2.91E+01	2.61E+02	9.79E+01	
Arsenic	2.21E+01	2.18E+01	1.96E+02	7.35E+01	
Barium	1.00E+04*	1.00E+04*	1.00E+04*	1.00E+04*	
Cadmium	7.38E+01	7.28E+01	6.53E+02	2.45E+02	
Chromium III	1.00E+04*	1.00E+04*	1.00E+04*	1.00E+04*	
Chromium VI	2.21E+02	2.18E+02	1.96E+03	7.35E+02	
Cobalt	1.48E+03	1.46E+03	1.00E+04*	4.90E+03	
Copper	2.95E+03	2.91E+03	1.00E+04*	9.79E+03	
Lead	2.58E+02	2.55E+02	2.29E+03	8.57E+02	
Manganese	1.00E+04*	1.00E+04*	1.00E+04*	1.00E+04*	
Mercury	1.10E+01	6.52E+00	3.84E+01	4.56E+01	
Molybdenum	3.69E+02	3.64E+02	3.26E+03	1.22E+03	
Nickel	1.48E+03	1.46E+03	1.00E+04*	4.90E+03	
Tin	1.00E+04*	1.00E+04*	1.00E+04*	1.00E+04*	
Zinc	1.00E+04*	1.00E+04*	1.00E+04*	1.00E+04*	
Dioxins / PCBs					
Dioxins (I-TEQ)	1.00E-03	1.00E-03	5.00E-03	1.00E-03	
PCBs	2.36E-01	2.26E-01	7.48E-01	7.56E-01	
Petroleum Carbon Ranges					
C6 - C8	1.41E+03	5.45E+02	1.00E+04*	1.00E+04*	1.00E+03
C9 - C16	2.24E+03	1.33E+03	1.00E+04*	1.00E+04*	3.00E+03
C17 - C35	1.00E+04*	1.00E+04*	1.00E+04*	1.00E+04*	5.00E+03
Other Inorganic Compounds					
Cyanide, free	1.48E+03	1.46E+03	1.00E+04*	4.90E+03	
Organometallics					
TBTO	2.21E+01	2.18E+01	1.96E+02	7.35E+01	

Notes:
(1) For Dioxins, the cleanup levels in USEPA Office of Solid Waste and Emergency Response (OSWER) Directive of 1998 have been adopted. The OSWER Directive value of 1 ppb for residential use has been applied to the scenarios of "Urban Residential", "Rural Residential", and "Public Parks", while the low end of the range of values for industrial, 5 ppb, has been applied to the scenario of "Industrial".
(2) Soil saturation limits for petroleum carbon ranges taken from the Canada-Wide Standards for Petroleum Hydrocarbons in Soil, CCME 2000.
(3) * indicates a 'ceiling limit' concentration.
(4) *** indicates that the C_{sat} value exceeds the 'ceiling limit' therefore the RBRG applies.

Table 2.2
Risk-Based Remediation Goals (RBRGs) for Groundwater and Solubility Limit

Chemical	Risk-Based Remediation Goals for Groundwater			Solubility Limit (mg/L)
	Urban Residential (mg/L)	Rural Residential (mg/L)	Industrial (mg/L)	
VOCs				
Acetone	1.00E+04*	1.00E+04*	1.00E+04*	***
Benzene	3.86E+00	1.49E+00	5.40E+01	1.75E+03
Bromodichloromethane	2.22E+00	8.71E-01	2.62E+01	6.74E+03
2-Butanone	1.00E+04*	1.00E+04*	1.00E+04*	***
Chloroform	9.56E-01	3.82E-01	1.13E+01	7.92E+03
Ethylbenzene	1.02E+03	3.91E+02	1.00E+04*	1.69E+02
Methyl tert-Butyl Ether	1.53E+02	6.11E+01	1.81E+03	***
Methylene Chloride	1.90E+01	7.59E+00	2.24E+02	***
Styrene	3.02E+03	1.16E+03	1.00E+04*	3.10E+02
Tetrachloroethene	2.50E-01	9.96E-02	2.95E+00	2.00E+02
Toluene	5.11E+03	1.97E+03	1.00E+04*	5.26E+02
Trichloroethene	1.21E+00	4.81E-01	1.42E+01	1.10E+03
Xylenes (Total)	1.12E+02	4.33E+01	1.57E+03	1.75E+02
SVOCs				
Acenaphthene	1.00E+04*	7.09E+03	1.00E+04*	4.24E+00
Acenaphthylene	1.41E+03	5.42E+02	1.00E+04*	3.93E+00
Anthracene	1.00E+04*	1.00E+04*	1.00E+04*	4.34E-02
Benzo(a)anthracene				
Benzo(a)pyrene				
Benzo(b)fluoranthene	5.39E-01	2.03E-01	7.53E+00	1.50E-03
Benzo(g,h,i)perylene				
Benzo(k)fluoranthene				
bis-(2-Ethylhexyl)phthalate				
Chrysene	5.81E+01	2.19E+01	8.12E+02	1.60E-03
Dibenzo(a,h)anthracene				
Fluoranthene	1.00E+04*	1.00E+04*	1.00E+04*	2.06E-01
Fluorene	1.00E+04*	1.00E+04*	1.00E+04*	1.98E+00
Hexachlorobenzene	5.89E-02	2.34E-02	6.95E-01	6.20E+00
Indeno(1,2,3-cd)pyrene				
Naphthalene	6.17E+01	2.37E+01	8.62E+02	3.10E+01
Phenanthrene	1.00E+04*	1.00E+04*	1.00E+04*	1.00E+00
Phenol				
Pyrene	1.00E+04*	1.00E+04*	1.00E+04*	1.35E-01
Metals				
Antimony				
Arsenic				
Barium				
Cadmium				
Chromium III				
Chromium VI				
Cobalt				
Copper				
Lead				
Manganese				
Mercury	4.86E-01	1.84E-01	6.79E+00	
Molybdenum				
Nickel				
Tin				
Zinc				
Dioxins / PCBs				
Dioxins (I-TEQ)				
PCBs	4.33E-01	1.71E-01	5.11E+00	3.10E-02
Petroleum Carbon Ranges				
C6 - C8	8.22E+01	3.17E+01	1.15E+03	5.23E+00
C9 - C16	7.14E+02	2.76E+02	9.98E+03	2.80E+00
C17 - C35	1.28E+01	4.93E+00	1.78E+02	2.80E+00
Other Inorganic Compounds				
Cyanide, free				
Organometallics				
TBTO				

Notes:
(1) Blank indicates that RBRG could not be calculated because the toxicity or physical/chemical values were unavailable, or the condition of Henry's Law Constant>1.00E-05 was not met for the inhalation pathway.
(2) Water solubilities for Petroleum Carbon Range aliphatic C9-C16 and greater than C16 generally are considered to be effectively zero and therefore the aromatic solubility for C9-C16 is used.
(3) * indicates a 'ceiling limit' concentration.
(4) *** indicates that the solubility limit exceeds the 'ceiling limit' therefore the RBRG applies.

Appendix E

Intervention Value downloaded from the website of Ministry of Housing, Spatial Planning and Environment, Netherland

Table 1a: **Target values and soil remediation intervention values and background concentrations soil/sediment and groundwater for metals. Values for soil/sediment have been expressed as the concentration in a standard soil (10% organic matter and 25% clay).**

	EARTH/SEDIMENT (mg/kg dry matter)			GROUNDWATER (µg/l in solution)			
	national background concentration (BC)	target value (incl. BC)	intervention value	target value shallow	national background concentration deep (BC)	target value deep (incl. BC)	intervention value
I Metals							
antimony	3	3	15	-	0.09	0.15	20
arsenic	29	29	55	10	7	7.2	60
barium	160	160	625	50	200	200	625
cadmium	0.8	0.8	12	0.4	0.06	0.06	6
chromium	100	100	380	1	2.4	2.5	30
cobalt	9	9	240	20	0.6	0.7	100
copper	36	36	190	15	1.3	1.3	75
mercury	0.3	0.3	10	0.05	-	0.01	0.3
lead	85	85	530	15	1.6	1.7	75
molybdenum	0.5	3	200	5	0.7	3.6	300
nickel	35	35	210	15	2.1	2.1	75
zinc	140	140	720	65	24	24	800

Table 1b: **Target values and intervention values for soil remediation soil/sediment and groundwater for inorganic compounds, aromatic compounds, PAH, chlorinated hydrocarbons, pesticides and other contaminants. Values for soil/sediment have been expressed as the concentration in a standard soil (10% organic matter and 25% clay).**

	EARTH/SEDIMENT (mg/kg dry matter)		GROUNDWATER (µg/l in solution)	
	target value	intervention value	target value	intervention value
II Inorganic compounds				
cyanides-free	1	20	5	1500
cyanides-complex (pH<5)[1]	5	650	10	1500
cyanides-complex (pH ≥5)	5	50	10	1500
thiocyanates (sum)	1	20	-	1500
bromide (mg Br/l)	20	-	0.3 mg/l[2]	-
chloride (mg Cl/l)	-	-	100 mg/l[2]	-
fluoride (mg F/l)	500[3]	-	0.5 mg/l[2]	-
III Aromatic compounds				
benzene	0.01	1	0.2	30
ethyl benzene	0.03	50	4	150
toluene	0.01	130	7	1000
xylenes	0.1	25	0.2	70
styrene (vinyl benzene)	0.3	100	6	300
phenol	0.05	40	0.2	2000
cresols (sum)	0.05	5	0.2	200
catechol(o-dihydroxybenzene)	0.05	20	0.2	1250
resorcinol(m-dihydroxybenzene)	0.05	10	0.2	600
hydroquinone(p-dihydroxybenzene)	0.05	10	0.2	800
IV Polycyclic aromatic hydrocarbons (PAH)				
PAH (sum 10) [4,14]	1	40	-	-
naphthalene			0.01	70
anthracene			0.0007*	5
phenatrene			0.003*	5
fluoranthene			0.003	1
benzo(a)anthracene			0.0001*	0.5
chrysene			0.003*	0.2
benzo(a)pyrene			0.0005*	0.05
benzo(ghi)perylene			0.0003	0.05
benzo(k)fluoranthene			0.0004*	0.05
indeno(1,2,3-cd)pyrene			0.0004*	0.05

Table 1b(continued): Target values and intervention values for soil remediation soil/sediment and groundwater for inorganic compounds, aromatic compounds, PAH, chlorinated hydrocarbons, pesticides and other contaminants. Values for soil/sediment have been expressed as the concentration in a standard soil (10% organic matter and 25% clay).

	EARTH/SEDIMENT (mg/kg dry matter)		GROUNDWATER (µg/l in solution)	
	target value	intervention value	target value	intervention value
V Chlorinated hydrocarbons				
vinyl chloride	0.01	0.1	0.01	5
dichloromethane	0.4	10	0.01	1000
1,1-dichloroethane	0.02	15	7	900
1,2-dichloroethane	0.02	4	7	400
1,1-dichloroethene	0.1	0.3	0.01	10
1,2-dichloroethene (cis and trans)??	0.2	1	0.01	20
dichloropropane	0.002#	2	0.8	80
trichloromethane (chloroform)	0.02	10	6	400
1,1,1-trichloroethane	0.07	15	0.01	300
1,1,2-trichloroethane	0.4	10	0.01	130
trichloroethene (Tri)	0.1	60	24	500
tetrachloromethane (Tetra)	0.4	1	0.01	10
tetrachloroethene (Per)	0.002	4	0.01	40
chlorobenzenes (sum)[5,14]	0.03	30	-	-
monochlorobenzene			7	180
dichlorobenzenes			3	50
trichlorobenzenes			0.01	10
tetrachlorobenzenes			0.01	2.5
pentachlorobenzene			0.003	1
hexachlorobenzene			0.00009*	0.5
chlorophenols (sum)[6,14]	0.01	10	-	-
monochlorophenols (sum)			0.3	100
dichlorophenols			0.2	30
trichlorophenols			0.03*	10
tetrachlorophenols			0.01*	10
pentachlorophenol			0.04*	3
chloronaphthalene	-	10	-	6
monochloroaniline	0.005	50	-	30
polychlorobiphenyls (sum 7)[7]	0.02	1	0.01*	0.01
EOX	0.3		-	

Table 1b(continued): Target values and intervention values for soil remediation soil/sediment and groundwater for inorganic compounds, aromatic compounds, PAH, chlorinated hydrocarbons, pesticides and other contaminants. Values for soil/sediment have been expressed as the concentration in a standard soil (10% organic matter and 25% clay).

	EARTH/SEDIMENT (mg/kg dry matter)		GROUNDWATER (µg/l in solution)	
	target value	intervention value	target value	intervention value
VI Pesticides				
DDT/DDE/DDD[8]	0.01	4	0.004 ng/l *	0.01
drins[9]	0.005	4	-	0.1
aldrin	0.00006		0.009 ng/l*	
dieldrin	0.0005		0.1 ng/l	
endrin	0.00004		0.04 ng/l	
HCH-compounds[10]	0.01^	2	0.05^	1
α-HCH	0.003		33 ng/l	
β-HCH	0.009		8 ng/l	
γ-HCH	0.00005		9 ng/l	
atrazine	0.0002	6	29 ng/l	150
carbaryl	0.00003	5	2 ng/l*	50
carbofuran	0.00002	2	9 ng/l	100
chlorodane	0.00003	4	0.02 ng/l*	0.2
endosulfan	0.00001	4	0.2 ng/l*	5
heptachloro	0.0007	4	0.005 ng/l*	0.3
heptachloro-epoxide	0.0000002	4	0.005 ng/l*	3
maneb	0.002	35	0.05 ng/l*	0.1
MCPA	0.00005#	4	0.02	50
organotin compounds[11]	0.001	2.5	0.05*-16 ng/l	0.7
VII Other contaminants				
cyclohexanone	0.1	45	0.5	15000
phthalates (sum)[12]	0.1	60	0.5	5
mineral oil[13]	50	5000	50	600
pyridine	0.1	0.5	0.5	30
tetrahydrofuran	0.1	2	0.5	300
tetrahydrothiophene	0.1	90	0.5	5000
tribromomethane	-	75	-	630

Notes to table 1:

1. *Acidity: pH (0.01 M $CaCl_2$). In order to determine whether pH is greater than or equal to 5, or less than 5, the 90 percentile of the measured values is taken.*
2. *In areas subject to marine influence higher values occur naturally (salt and brackish water).*
3. *Differentiation by clay content: (F) = 175 = 13L (L = % clay).*
4. *PAH (sum of 10) here means the total of anthracene, benzo(a)anthracene, benzo(k)fluoroanthene, benzo(a)pyrene, chrysene, phenantrene, fluoroanthene, indeno(1,2,3-cd)pyrene, naphthalene and benzo(ghi)perylene.*
5. *'Chlorobenzenes (sum)' here means the total of all chlorobenzenes (mono-, di-, tri-, tetra-, penta- and hexachlorobenzene).*
6. *'Chlorophenols (sum)' here means the total of all chlorophenols (mono-, di-, tri-, tetra- and pentachlorophenol).*
7. *In the case of the intervention value, 'polychlorobiphenyls (sum)' means the total of PCB 28, 52, 101, 118, 138, 153 and 180. For the target value it refers to the total excluding PCB 118.*

8. *'DDT/DDD/DDE' above means the sum of DDT, DDD and DDE.*
9. *'Drins' above means the sum of aldrin, dieldrin and endrin.*
10. *'HCH compounds' above means the sum of á-HCH, â-HCH, ã-HCH and ä-HCH.*
11. *The intervention value applies to the sum of the concentrations of organotin compounds encountered.*
12. *'Phthalates (sum)' above means the total of all phthalates.*
13. *'Mineral oil' is defined in the analysis standard. Where the contamination is due to mixtures (e.g. gasoline or domestic heating oil), then not only the alkane content but also the content of aromatic and/or polycyclic aromatic hydrocarbons must be determined. This aggregate parameter has been adopted for practical reasons. Further toxicological and chemical disaggregation is under study.*
14. *The values for the sum of polycyclic aromatic hydrocarbons, the sum of chlorophenols and the sum of chlorobenzenes in earth/sediment apply to the total concentration of the compounds belonging to the relevant category. If the contamination is due to only one compound of a category, the value used is the value for that compound. Where there are two or more compounds the value for the total of these compounds applies, etc. For earth/sediment, effects are directly additive (i.e. 1 mg of substance A has the same effect as 1 mg of substance B) and can be tested against an aggregate standard by summing the concentrations of the substances involved. In the case of groundwater, effects are indirectly additive and are expressed as a fraction of the individual intervention values (i.e. 0.5 of the intervention value of substance A has the same effect as 0.5 of the intervention value of substance B). This means that an addition formula must be used to determine whether an intervention value is exceeded. The intervention value for the sum of a group of substances is exceeded if:*

$$\{ óc_i) / I_i \geq 1,$$

where: C_i = *measured concentration of a substance in the group of substances in question*
I_i = *intervention value for the group.*

**numeric value below the detection level/quantification level or measurement method is lacking*
 # These target values have not been tested in HANS. All the other values have been tested in HANS.
^ The individual standards in INS are given in the Fourth Policy Document on Water Management along with the sum standards marked ^.

Table 2a: Target values , indicative levels for serious soil contamination and background concentrations soil/sediment and groundwater for metals. . Values for soil/sediment have been expressed as the concentration in a standard soil (10% organic matter and 25% clay).

	EARTH/SEDIMENT (mg/kg dry matter)			GROUNDWATER (µg/l in solution)			
	national background concentration (BC)	target values (incl. BC)	indicative level serious contamination	target values shallow	national background concentration deep (BC)	target values deep (incl. BC)	indicative level serious contamination
I Metals							
beryllium	1.1	1.1	30	-	0.05*	0.05*	15
selenium	0.7	0.7	100	-	0.02	0.07	160
tellurium	-	-	600	-	-	-	70
thallium	1	1	15	-	<2*	2*	7
tin	19	-	900	-	<2*	2.2*	50
vanadium	42	42	250	-	1.2	1.2	70
silver	-	-	15	-	-	-	40